Moving Upstream: The Role of Tobacco Clean Air Restrictions on Educational Inequalities in Smoking Among Young Adults

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Running title: The effect of smoking bans on educational inequalities in smoking

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Abstract

Education affords a range of direct and indirect benefits that promote longer and healthier lives, and stratify health lifestyles. We use tobacco clean air policies to examine whether policies that apply universally—interventions that bypass individuals' unequal access and ability to employ flexible resources to avoid health hazards—have an effect on educational inequalities in health behaviors. We test theoretically informed but competing hypotheses that these policies either amplify or attenuate the association between education and smoking behavior. Our results provide evidence that interventions that "move upstream" to apply universally regardless of individual educational attainment, here tobacco clean air policies, are particularly effective among young adults with the lowest levels of parental or individual educational attainment. These findings provide important evidence that upstream approaches may disrupt persistent educational inequalities in health behaviors. In doing so, they provide opportunities to intervene on behaviors in early adulthood that contribute to disparities in morbidity and mortality later in the life course. These findings also help assuage concerns that tobacco clean air policies increase educational inequalities in smoking by stigmatizing those with the fewest resources.

Education affords a range of direct and indirect benefits that promote longer and healthier lives (Mirowsky and Ross 2003; Authors 2007; Cutler and Lleras-Muney 2010; Authors 2013), and stratify health lifestyles (Pampel et al. 2010). It is a component of the flexible resources—knowledge, power, money, and prestige—that people use to avoid preventable health risks (Phelan et al. 2004; Masters et al. 2015), resources often transmitted across generations. Advances in medicine and the availability of new health knowledge accentuate the value of these flexible resources as a means to improve health; they enable the adoption of new technologies and beneficial health behaviors, or facilitate the cessation of unhealthy ones (Gortmaker and Wise 1997; Link et al. 1998; Frisbie et al. 2004; Lichtenberg and Lleras-Muney 2005; Glied and Lleras-Muney 2008; Chang and Lauderdale 2009; Price and Simon 2009; Polonijo and Carpiano 2013; Yang et al. 2014; Baker et al. 2017). Over time and across different populations, new information about health risks can prompt a widening of educational inequalities in exposure to risks and subsequent health outcomes.

Whether strategic policy interventions help narrow these gaps is an important question for demographers (Baker et al. 2017) and others (Phelan et al. 2010; Bambra 2010; Sanson-Fisher et al. 2014). In this article, we use tobacco clean air acts (colloquially known as “smoking bans”) to assess the efficacy of such policies to remedy educational disparities in smoking. Our broader objective is to determine whether policies that apply universally have an effect on the magnitude of educational inequalities in health behaviors. Theoretically, “upstream” policies counteract the capacity of individuals to employ unequally distributed flexible resources to avoid health hazards by applying changes universally. Below, we posit several theoretically informed but competing hypotheses about the effects of smoking bans on educational gradients in smoking, and offer a robust test of these hypotheses based on detailed longitudinal data.

Our approach offers three key advantages over previous work. Although prior cross-sectional or aggregate level analysis revealed little change in educational disparities in smoking prevalence after passage of smoking bans (Pampel 2009), we employ *within-person analyses*. This approach allows us to examine whether exposure to smoking bans changed the association between education and smoking, providing a stronger causal conclusion. An additional strength is that our data include information about state, county, and city-level smoking bans, allowing us to consider local policy contexts typically excluded from past studies. Finally, we examine smoking rates during young adulthood, a key point in the life course when smoking habits form and begin to contribute to broader inequalities in health and mortality (Pampel et al. 2014; Authors 2013). This empirical case has clear implications for understandings of social inequalities in health, particularly the relationship between education and smoking.

Background

In the U.S., educational attainment is closely related to health and longevity (Conti et al 2010; Montez et al 2012; Authors 2013). These advantages may result either from benefits afforded by parental educational attainment or those obtained by an individual's own educational attainment, and often both. Advantaged children are positioned to gain from their parents' attainments because resources are often transmitted from one generation to the next (Hayward and Gorman 2004; Maralani 2014), and health habits set and reinforced early in life help determine children's lifestyles, tastes, and preferences for specific behaviors (Cockerham 2005; Bourdieu 1984). Formal schooling also facilitates human capital accumulation, helping individuals gain employment and earn income (Hummer and Lariscy 2011), while stratifying them into social and work contexts that contribute to unequal exposures to health hazards or reinforce specific health lifestyles (Pampel et al. 2010; Warren et al. 2004). Education also helps develop skills, confidence, and self-assurance, influencing a person's ability to understand and act on new health information and to avoid risks (Mirowsky and Ross 2003; Cutler and Lleras-Muney 2010). The result is a strong educational gradient in health that persists across generations.

The history of smoking in the U.S. provides a useful example of how educational gradients in health emerge. Until the mid-twentieth century, people knew little about smoking's risks. In 1964, however, the U.S. Surgeon General warned about its health hazards (Department of Health and Human Services 2014). This warning was published in the midst of broader changes in the rise of medical authority (Starr 1982), the medicalization of behaviors (Conrad 1992), and the epidemiological shift from infectious to chronic diseases as leading causes of death (Cutler and Miller 2005). Together, these trends resulted in a broad shift toward understanding, observing, and avoiding individual risk factors that contribute to poor health (Link and Phelan 1995; House 2002; Clarke et al. 2003; Boyer and Lutfey 2010). Along with other behaviors, such as unhealthy eating or physical inactivity, smoking became a target for individual behavioral modification (Department of Health, Education, and Welfare 1964).

With the emergence of information about the risks associated with smoking, a negative educational gradient in smoking materialized (Farrell and Fuchs 1982; Kenkel, Lillard, and Mathios 2006; Link 2008; de Walque 2010; Baker et al. 2017). This was due, in part, to the resources that higher levels of education provide, which allowed individuals with higher education levels to make more effective use of new information. During ensuing decades, people abstained from smoking at higher rates if their parents had higher levels of education or if they completed more schooling themselves (Pampel et al. 2014). Access to more economic and social resources facilitates cessation, and highly educated people tend to use more effective resources when attempting to quit smoking (Honjo et al. 2006; Reid et al. 2010). These processes inhibited smoking initiation and increased opportunities to stop both social and heavy smoking among the more highly educated.

Over time, the steepening education-smoking gradient became entrenched across generations, and set the stage for shifts in the social status of smoking through stigmatization (Stuber et al. 2008). Attempting to reduce smoking, public health campaigns targeted behaviors among the least educated, stigmatizing smokers by framing the behavior as immoral and lower status (Bell et al. 2010). Over time, avoiding cigarettes became a way for higher status individuals to distinguish themselves from less advantaged peers (Pampel 2006). Conversely, smoking became more highly stigmatized within certain segments of the population, prompting the denormalization of smoking and changing norms around tobacco use. Even more, smoking can be a form of coping with stressors that more frequently befall disadvantaged individuals (Pampel et al. 2014; Bennett et al. 2005), further reinforcing the education-smoking gradient. By the end of the 20th century, smoking was a behavior that reflected health lifestyles of people whose parents had lower levels of educational attainment; in turn, parents reinforced these habits intergenerationally (Cockerham 2005).

The educational gradient represents a “fundamental cause” (Link and Phelan 1995) or “underlying cause” (Rose 1992) of unequal health. Regardless of shifts in health risks over time, the benefits of educational attainment enable people to avoid preventable causes of death (Masters et al. 2015). In the absence of efforts to address these underlying causes of health inequalities, e.g. the ability to use unequally distributed flexible resources to avoid health hazards, the association between educational attainment and health and longevity persists. Changes in tobacco policy in the U.S. offer opportunities to examine whether we can intervene on these fundamental causes. Some policies aim to “move upstream,” inducing change at the population-level by bypassing individual-level differences in knowledge, access to flexible resources, or health lifestyles by restricting behavior among everyone within specific spaces (Bird and Rieker 2008; Capewell and Graham 2010). Importantly, the present study addresses a need identified by Williams and colleagues (2008) to evaluate policies that “move upstream” to address population health disparities.

In the 1970s and 1980s, focus shifted from the individual risks of smoking to those posed by passively inhaled secondhand smoke, motivating a few key states (Arizona, Connecticut, and Minnesota) to restrict smoking in certain spaces (Widome et al. 2010). Over decades, fueled in part by the 1992 Environmental Protection Agency report on the public health impact of involuntary secondhand smoke exposure, these policies frequently diffused from cities to states through a process of bottom up federalism (Shipan and Volden 2006). On the ground, these laws constrain individual choices about smoking behavior (Authors 2016), shifting the context in which everyone—smokers and nonsmokers alike—find themselves. Even after accounting for a host of other individual and contextual constraints, these policies have a clear effect, lowering the prevalence of smoking (Fichtenberg and Glanz 2002; Authors 2016; 2018), particularly among youth (Farrelly et al. 2013; Song et al. 2015), reducing the chance that they will become established smokers.

Upstream Policy Intervention: Tobacco Clean Air Acts as an Example

Multiple targets of intervention exist on the spectrum of upstream social forces that shape health. On one hand, policy interventions could involve restructuring systems that generate unequal access to flexible resources, for example the educational system, theoretically altering educational inequalities in morbidity and mortality (Authors 2013). Prior experimental work suggests that these approaches yield important benefits, particularly if applied to children early in the life course (Zajacova and Lawrence 2018). On the other hand, upstream policy interventions could neutralize individuals' abilities to unequally employ flexible resources by implementing a policy that targets population health regardless of socioeconomic position, and in doing so, redress health inequalities. Smoking bans exemplify this second type of upstream policy intervention (McKinlay and Marceau 2000a,b). Rather than attempting to motivate behavioral change at the individual level, through educational campaigns about the risks of smoking, for example, smoking bans "move upstream" by equitably limiting the spaces where people can smoke. This approach counteracts the capacity for some to employ individual flexible resources to their advantage more than others (McLaren et al. 2010). Moreover, even though smoking bans target one health behavior, this health behavior impacts a constellation of health outcomes (Fenelon and Preston 2012), and thus is broad in its effect.

Although increasingly the subject of theoretical discussion (Frohlich and Potvin 2008; McLaren et al. 2010), the empirical effects of upstream policy interventions on educational inequalities in health deserve more attention (Sanson-Fisher et al. 2014). Do upstream health policy interventions (like smoking bans) influence the association between educational attainment and health behaviors, such that gradients are reduced? Or are their benefits disproportionately clustered among those in advantaged social positions, resulting in widening gaps? We offer theoretically informed motivations for both outcomes.

There are two important features of smoking bans that make them effective at changing smoking behavior. First, they uniformly restrict everyone from smoking in certain spaces–such as bars or restaurants–within a city, county, or state.[1] Second, they may intensify the *denormalization* of smoking by symbolically signaling that smoking is abnormal (Stuber et al. 2008; Author 2009; Authors 2018). In addition to smoking becoming less acceptable, smokers must segregate themselves from others, typically outside of social spaces. As Stuber et al. (2008:422) describe, "one need only look outside at the huddle of smokers commonly seen outside public buildings in inclement weather to witness the decreased social standing of smokers relative to non-smokers." By denormalizing smoking, smoking bans alter injunctive norms around smoking (Cialdini et al. 1990) and normative beliefs about whether others approve or disapprove of smoking. Public health policymakers strategically used this to deter smoking through smoking bans (Bell et al. 2010).

Denormalization is particularly effective to change behavior during the transition to adulthood, and changes during this life stage often have ripple effects on adult health and longevity (Fenelon and Preston 2012). Smoking initiation and cessation occur most frequently during adolescence or young adulthood (Messer et al. 2008; Chen and Jacques-Tiura 2014), in many cases shaping lifelong smoking habits. In this article, we examine smoking behavior changes among a cohort that came of age during a period of rapid smoking ban implementation, rather than older cohorts whose smoking behavior was already firmly entrenched.

Hypotheses: Exacerbating or Ameliorating the Education-Smoking Gradient?

We offer competing hypotheses based upon theoretical considerations within the existing

[1] We distinguish between tobacco clean air acts (i.e., smoking bans) and other tobacco related policies that are less universal in their application, including (1) excise taxes, (2) ad restrictions, and (3) single cigarette sales restrictions. Such other policies are more fundamentally dependent upon individual use of the flexible resources conferred by education. In this manner, they are less comprehensive and universal in their application and effect.

literature, an approach that affords the opportunity to build on existing theory for population health studies (Carpiano and Daley 2006; Chamberlain 1965). First, there are reasons to expect that smoking bans may *widen* the association between education and smoking behavior. By intensifying denormalization, smoking bans may have amplified educational disparities in smoking that already existed (Bell et al. 2010). People who smoked were not forced to quit; they were required to relocate to smoke and indirectly pressured to quit through denormalization. However, Stuber and colleagues (2008) offer evidence that current or former smokers with higher levels of education are more susceptible to smoker-related stigma. Thus, denormalization may have influenced behavior unequally across educational groups, motivating well-educated people to quit at higher rates. Aside from denormalization processes are the aforementioned direct and indirect benefits of parental and individual education, which aid tobacco cessation by determining health lifestyles subject to policy (Pampel, Krueger and Denney 2010; Cockerham 2005). Moreover, educational homophily in social networks (McPherson et al. 2001) may contribute by determining whether social ties reinforce or undermine policy efforts to reduce smoking (Mercken et al. 2010; Umberson et al. 2010). We use indicators of parental and individual educational attainment to test whether smoking bans widen the association between education and smoking behavior.

> H_{1A}: Smoking bans will result in greater reductions in smoking among young adults with more highly educated parents.

> H_{1B}: Smoking bans will result in greater reductions in smoking among more highly educated young adults.

On the other hand, by applying universally, smoking bans theoretically circumvent differences in flexible resources, lifestyles, or preferences. Prior examples suggest that upstream policy interventions narrow gaps in socioeconomic, racial, or gender health inequalities. In the

U.S., examples occur within different geographic or institutional boundaries (i.e., national, state, city) or within specific institutions such as health care clinics or schools. After implementation, universal policies or interventions reduced disparities across various outcomes: cereal fortification reduced inequalities in folate status (Dowd and Aiello 2008), mandatory seat belt laws decreased inequalities in seat belt use (Harper et al. 2014), and clinic-level screening protocols reduced inequalities in vitamin D supplementation (Author 2013). For smoking specifically, prior research found that smoking bans narrowed gender differences in smoking (Authors 2016). The unequal diffusion of medical innovation provides another vantage point to estimate whether policies that apply universally affect health inequalities (Capewell and Graham 2010). In these instances, the *equitable* implementation of best-practice interventions across groups hold the potential to eliminate differences in outcomes such as coronary heart disease (Kivimäki et al. 2008) and colorectal cancer (Clouston et al. 2016). These studies provide evidence that implementing universal policies within specific institutions or geographic boundaries reduce or narrow socioeconomic inequalities in health. Thus, smoking bans may narrow educational inequalities in smoking among young adults because the policies applied uniformly across the education gradient.

H_{2A}: Smoking bans will result in greater reductions in smoking among young adults whose parents have the lowest educational attainment.

H_{2B}: Smoking bans will result in greater reductions in smoking among young adults with the lowest educational attainment.

In our analysis, we test these hypotheses using a strong research design that allows for identification of smoking ban effects on smoking behavior by education. We venture that these findings offer evidence about the broader effects of one type of upstream policy intervention on educational inequalities in health behaviors.

Data and Analytic Approach

Individual-Level Data: NLSY97

Individual-level data come from the National Longitudinal Survey of Youth 1997 (NLSY97)—a large, nationally representative, geocoded sample (*N*=8,984) designed to track the transition to adulthood. Adolescents ages 12 to 16 were randomly sampled in 1997 and surveyed annually thereafter. The retention rate was nearly 80 percent in 2013. The restricted-access, geocoded NLSY97 identifies respondents' core-based statistical area (CBSA; i.e. metropolitan or micropolitan area), county, and state. We analyzed a subset of respondents whose city of residence was identifiable by combining CBSA and county information with information about whether the respondent lived in a principal city within the CBSA. Thus, we restrict our analyses to those living in the largest principal city of a CBSA, given the importance of the local level within a multilevel policy context. We restrict analyses to waves 2004 and later (ages 19-31), as this was the first year in which CBSA data are available.[2] This subset amounts to 22,534 observations among 4,905 individuals within 510 cities. The analyzed subset is similar to the whole sample on all individual-level variables used in our models, with the exception that those in the subset were more likely to work. After removing missing data, the analytic sample in our models is 20,626 observations among 4,624 respondents for parental education and 21,506 observations among 4,806 respondents for individual education.

Dependent Variables. Each year, respondents who indicated they ever smoked an entire

[2] Before 2004, only metropolitan statistical area (MSA) was available. Although increasing time-points, using MSA (>50,000 people) rather than CBSA (>10,000 people) reduces the number of cities (and respondents) analyzed. Given our focus on local policy, we prioritized adding more cities over time-points, while diversifying the cities given CBSAs' lower population threshold, such that not only large cities are included. While we restrict analyses to age 19 and older, we do not view this restriction as negative since this constitutes an age when young adults begin to frequent nightlife establishments, which have the most between-city variation in smoking bans.

cigarette were asked the number of days and cigarettes smoked during the past 30 days. We created a binary outcome variable indicating those who report at least 8 cigarettes in the past 30 days, which captures those who smoked at least intermittently (Tindle and Shiffman 2011), while excluding those who may have only experimented. Although these respondents smoke at least a couple cigarettes per week, we refer to them as "smoking" for simplicity. Across the observation period, respondents smoked at least intermittently in the past month on 28.9 percent of observations.[3] In these observations, the mean number of days smoking is 24.8 (SD=8.41), and the mean number of cigarettes smoked per smoking day is 9.6 (SD=8.57). Although a heterogeneous group of smokers (indicated by the standard deviation), the mean indicates that we generally captured a group of regular smokers. We describe alternative codings of smoking status in the discussion section. In Table 1, we show descriptive statistics, pooled across all years, for smoking and all other variables overall and by smoking status.

[Table 1]

Stratifying Variables. As described below, our modeling strategy precludes the inclusion of time-invariant predictors. However, we can examine the differing effect of time-varying factors by stable predictors via interactions. We modeled the impact of smoking bans separately by parental and individual educational attainment. We measured parental education by respondent-reported parents' highest education level with four categories derived from the number of years of school completed (less than high school, high school, some college or

[3] The rate of any past 30 day smoking in the sample (34.5%) compares well to young adults (18-25) in the National Survey on Drug Use and Health across these years, decreasing from 39.5% in 2004 to 33.5% by 2011 (SAMHSA 2016:7).

Associate's degree, and Bachelor's degree or higher).[4] For individual educational attainment, we used a measure of educational degree by the end of the observation period; we distinguish between some college without a degree and an Associate's degree bringing the total number of categories to five.[5]

We recognize that individual educational attainment by the end of the observation period may create temporal order issues with our predictors. However, this strategy has been justified elsewhere in tobacco use studies since factors that influence smoking and educational attainment occur during childhood and adolescence (Maralani 2014; Pampel et al. 2014). As Maralani states, "[d]ifferences in smoking by completed education are apparent at ages 12-18, long before that education is acquired" (2014:27). In other words, the benefits of higher levels of education emerge even before individuals complete schooling; these stratification processes are set in motion prior to attainment. Importantly, our modeling strategy nets out characteristics that give rise to these differences. In addition, for two categories of individual educational attainment, less than high school and high school diploma, respondents completed education prior to our first included observation. Nonetheless, we also measured education by age 25 to distinguish late completion of higher education from on-time or early completion and found the same results. We return to possible implications of this coding decision in the discussion.

Covariates. We included several individual-level time-varying covariates in the models.

[4] The parental measure is derived from years of schooling completed; thus, we cannot be certain where someone with a GED would group themselves (i.e., "12 years" or a lower year based on when they left formal schooling).
[5] Although a small group, we separate Associate's degree recipients because research shows that, relative to those who leave college without a degree, the returns to an Associate's degree are greater and helps its recipients' weather recessionary periods (Vuolo, Mortimer, and Staff 2016; De Alva and Schneider 2013; Zaback et al. 2012; Kalogrides and Grodsky 2011; Kane and Rouse 1995). In many cases, the Associate's degree is a credential for vocational preparation, leading to tracking into occupations that require specialized knowledge in a way that dropping out of college would not. Thus, the Associate's group likely has more flexible resources to tap into than those who do not complete college.

In a longitudinal dataset, researchers must choose between year and age as the time metric based upon theoretical considerations (Yang 2010). Given that age is central to substance use patterns among young adults, we use age. Regarding family, we included indicator variables for whether respondents lived with a parent, were married, and had children (Brown & Rinelli, 2010; Fleming et al., 2010). For work factors, we included categorical variables for job status, occupational sector, and job schedule (Johnson, 2004). Finally, we accounted for residential migration via a dummy variable for a past year move across at least one county.

Policy-Level Data: Americans for Nonsmokers' Rights Foundation

Policy-level data come from the Americans for Nonsmokers' Rights Foundation (ANRF) tobacco policy database. The ANRF collected a complete national repository of tobacco-related laws by date enacted. The main predictor variable is whether the respondent lived in a locale with a comprehensive smoking ban, defined as policies mandating that all workplaces, bars, and restaurants are completely smoke-free. We created a location-year dataset for each data year. Since state or county policies are not independent of city policy (i.e., a state policy automatically means a city ban, and therefore, the variables must match), we recoded cities within states or counties with bans to reflect this status. Thus, we measure all policy information at the city-level. FIPS codes linked the geocoded NLSY97 to ANRF data at the city-level, allowing us to determine the tobacco policy context within which respondents were located. We used the same procedure to include additional policies as controls, incorporating the main domains of tobacco control (Friend et al. 2011), including single cigarette sales, any advertising restriction, and excise taxes per pack. Although useful as covariates, these policies do not have comparable universal application in restricting behavior in the same manner as smoking bans.

Figure 1 shows the percentage of respondents living under a comprehensive ban by year. In 2004, 14.9 percent of respondents lived in a city with a comprehensive ban, increasing to 58.7 percent by 2011, a rapid proliferation that provides within-person variability necessary for our modeling procedure.

[Figure 1]

City-Level Data: U.S. Census

Several city-level measures from Census data are included. To include both population size and density, we created a categorical measure of population, while density is considered continuous (logged due to skewness). To measure ties to the community, we used the percentage of owner-occupied housing. We included the percentage of female-headed households, a useful proxy for other economic measures such as poverty and income (LeClere et al. 1998). Finally, we included the percentage of non-Hispanic whites and minors to account for community racial and age composition, respectively.

Methods

We use individual-level panel fixed effects (FE) linear probability models (LPMs) to predict smoking (Winship and Morgan 1999; Halaby 2004; Allison 2009). Fixed effect models have several advantages to best isolate the relationship between smoking bans and individuals' smoking behaviors. First, they model each individual's change in behavior over time as policy changes, allowing us to interpret the effect of enacting a smoking ban on a given individual's smoking. Second, the models net out the effect of stable individual-level characteristics by person-centering the variables, effectively removing sources of unobserved heterogeneity for all but time-varying predictors. For our analysis, parental and individual level educational attainment models account for unobserved differences in latent propensities related to both education and tobacco use. Therefore, they net out effects of static characteristics that might mediate the observed effect between smoking bans and smoking behavior that occurred or solidified during childhood and adolescence, including but not limited to parenting style, parental smoking, high school achievement, psychological orientations, teenage peer effects, race/ethnicity, and gender. Together with time-varying controls, our modeling approach allows us to make strong causal conclusions regarding the effect of smoking bans on a person's probability of smoking.

We rely on FE LPMs because they provide certain advantages over FE logit models. First, nonlinear FE models do not provide a manner to estimate predicted probabilities without making assumptions about the value of the fixed effects or dropping the fixed effects component, and thus the benefits of causal interpretation (Cameron and Trivedi 2009; 2010). Beyond using the regression coefficients to observe the difference in the effect of smoking bans between education groups, predicted probabilities allow us to observe changes in the education-smoking gradient.[6] Second, in the FE linear framework, the coefficients for interactions with a static characteristic such as education have a more intuitive interpretation than the odds ratio.

We note that, as it is necessary to center in the FE framework, an analytic level for the city is not formally included in our models. A cluster correction for the city cannot be included because individuals are not fully nested in cities; that is, individuals move across cities over time. To be clear, the variables for cities, including policy, are time-varying, which actually locates them at the lowest level of the model with the time-varying individual-level measures. However,

[6] The main drawback for LPMs is that predicted probabilities are not bounded between 0 and 1, but this was not an issue for our predictions.

there is no formal adjustment for average differences in smoking between cities. Although, if an individual does not move, any effect of static city-level propensities for smoking that would affect that individual would be netted out of the model. Similarly, there are many cities that have just one or few respondents, such that clustering would not affect the results. One possible solution is to use hierarchical models that include both between- and within-person effects for time-varying measures, as these produce the same results as the FE model (Halaby 2003), but then to nest the individual within cities to adjust the intercept for differences in smoking across cities. This strategy produced similar results.

Results

We first describe the relationship between parental and individual educational attainment in Table 2, which reveals that the two measurements may have unique effects. Although many respondents achieve the same level of education as their parents (shaded cells in Table 2), a sizable number over- or underachieve.

[Table 2]

Next, we show smoking behavior by parental and individual educational attainment, revealing differences for the two measures. The top graph in Figure 2 displays the percentage of respondents reporting past month smoking by parental educational attainment from ages 19 to 30; the bottom displays the same information by individual educational attainment. For parental educational attainment, there is no consistent pattern, with most lines overlapping. By contrast, there is a clear educational gradient for individual educational attainment across the entire period. For additional detail, the numbers depicted in Figure 2 are shown in tabular form in the top half of Appendix A; the bottom half shows the percentage of smokers in each education category by age. This partial but substantial mismatch between parental and individual educational attainment warrants distinct analyses. Of course, these differences do not speak to the effect of policy. Thus, we turn to individual-level FE models predicting the probability of past month smoking.

[Figure 2]

Parental Education Attainment

In Table 3, we show results from models that interact smoking bans with our two measures of education. These models test whether there are differential effects of smoking bans across education categories. In Model 1, we show the overall effect of smoking bans prior to considering education or time-varying controls, but controlling for individual-level fixed effects. When an individual resides in a location with a smoking ban, the probability of smoking is 0.036 lower than when they reside in a location without a ban (p<.001). In Model 2, we add controls, where the effect is reduced to 0.020 but remains significant (p<.01). These findings for the overall effect of smoking bans confirm our results from alternative modeling strategies in prior work (Authors 2016).

[Table 3]

In Models 3 and 4, we show the interaction with parental education. Here, the main effect represents the effect of smoking bans specifically for the baseline of less than high school, and the pattern is similar regardless of the inclusion of controls. With controls (Model 4), we find that in years when those in the less than high school group live in a location with a smoking ban, their probability of smoking is 0.064 lower (p<.001). The interaction coefficients show whether the smoking ban effect is different for the other education categories. Each coefficient leads to the same conclusion: the smoking ban effect is significantly different for the three higher education categories relative to that of less than high school. Adding the interaction coefficient to the main effect, we see that the effect of bans on smoking is much smaller for the higher education categories. The effect of the smoking ban is a reduction in the probability of smoking of only 0.001, 0.025, and 0.015 for those whose parents' education is high school, some college/Associate's, or Bachelor's, respectively. By testing the linear combination of the main effect of smoking bans and each of the coefficients, we find that each of these group-specific values for the effect of smoking bans are not statistically significant. These results provide evidence supporting Hypothesis H_{2A}: tobacco clean air policies prompted the greatest reductions in smoking among young adults whose parents had the lowest educational attainment.

We show predicted probabilities for parental education in Figure 3.[7] As reflected in Figure 2, rates of use are rather similar across parental educational attainment. But while the three lowest parental education categories have similar predicted probabilities of smoking (30%-32%), smoking bans were only significant for those with less than a high school degree, decreasing their predicted probability from 0.32 in years not living in a location with a ban to 0.24 in years with a ban. This finding represents a significant decline for those whose parents had less than a high school degree.

[Figure 3]

[7] While the models shown can produce in-sample predicted probabilities, they cannot produce out-of-sample predicted probabilities, as multiplying the smoking ban effect by zero in the interaction model also eliminates the education variables from the model (see StataCorp 2017:447-450). We can, however, derive these predicted probabilities from separate models by education subgroup, which is the approach taken here. These separate models are shown in Appendices B and C. As expected, the smoking ban coefficient is similar to that of the main effect in the interaction models for the less than high school categories, and the sum of the main effect and the respective education category for the higher levels of education. Any slight differences between the two modeling approaches are due to differential effect of the controls across education groups. For both parental attainment and individual attainment, the significant effects for those in the less than a high school education category are reaffirmed and the small non-significant effects computed in the interaction models are reaffirmed, now corresponding to the coefficients of the respective education categories. While we caution against direct comparison of the coefficients, the two modeling approaches produce very similar results in terms of the magnitudes of the effects, providing additional evidence for the robustness of our results.

Individual Educational Attainment

As demonstrated in Table 2 and Figure 2, distinct analyses by parental and individual educational attainment are warranted. We have five categories for individual educational attainment because the data allow us to separate respondents who achieved some college with no degree from those with an Associate's degree. For individual educational attainment, we show results in Models 5 and 6, depicting similar results to parental education that are consistent for models without and with controls. Using the latter, the probability of smoking is 0.086 lower for those with less than high school education when they live in a location with a smoking ban compared to when they do not (p<.001). With the exception of the small group of respondents with an Associate's degree, the effect of the smoking ban is significantly smaller for those in the higher education categories. Adding the main and interactive effects produces effects of the ban on smoking of a mere 0.018, 0.010, and 0.001 for those with high school degrees, some college, and Bachelor's, respectively.[8] Again by testing the linear combination of the main effect of smoking bans and each of the coefficients, we find that each of these group-specific values for the effect of smoking bans are not statistically significant. Consistent with our findings for parental educational attainment, these findings provide evidence supporting Hypothesis H_{2B}: policies resulted in the greatest reductions in smoking among young adults with the lowest level of education.

Turning to predicted probabilities for individual educational attainment in Figure 4, we see that overall there is a much stronger educational gradient when considering the respondents' own attainment, similar to the pattern in Figure 2. Again, the significant effect of smoking bans is apparent for the group with less than high school education. The predicted probability of

[8] The calculated smoking ban effect for those with an Associate's degree is -0.068 (p < .01).

smoking for years when they did not live in a location with a ban is 0.49, which declined to 0.40 for years when they did live in a location with a smoking ban—the same as the predicted value for those with a high school degree who do *not* live in a location with a ban. Although there is still a persistent educational gradient, this shift is significant according to our models: enacting smoking bans lowers smoking rates among individuals with the lowest level of education to rates similar to those in the next highest category of education. We observe a similar trend whereby enacting smoking bans prompts those with an Associate's degree to have predicted probabilities closer to those with the next highest educational category (Bachelor's degree or higher) when living in a location with a ban. Both of these results reflect an important shift, particularly for a health behavior that is hard to change such as smoking, suggesting a general flattening across the gradient.

[Figure 4]

Additional Results

In general, few significant time-varying controls occur across the models. In the models for both measures of education, there is a significant within-person reduction of 0.008 in the probability of smoking for a $1 increase in excise taxes (p<.05). Across all models, the effect of a one-unit increase in female-headed households results in a decrease of 0.006 in the probability of smoking (p<.05). In years living with a parent, the probability of smoking is about 0.02 lower (p<.01) for both measures of education. Finally, according to the marginal effects given the inclusion of a squared term, respondents have a steady probability of having smoked in the past month between ages 18 and 24, and then a decreasing probability through age 31 (p<0.05).

We conducted sensitivity analysis regarding our coding of individual educational attainment. Research has shown that those with a GED (9.1% of our observations) have smoking rates similar to those with less than a high school degree relative to those with a traditional high school diploma (Kenkel et al. 2006; Zajacova 2012; Schoenborn 2017). Of course, these differences in rates do not speak to differential effects by policy, which may differ given the flexible resources potentially provided by the credential. We modeled GED as a separate category and found that the effect of smoking bans was significantly different from those with less than high school but similar to that of those with a high school degree (Appendix D), supporting our choice to include those with a GED in the latter category.[9] The credential earned by completing a GED has specific benefits (Murnane, Willett, and Boudett 1999; Murnane, Willett, and Tyler 2000). In this instance, it is likely that the high school credential, whether earned through a traditional degree or a GED, allows people to tap into flexible resources to a greater degree compared to those without such credentialing.

Ultimately, our results reveal that even after controlling for stable individual-level characteristics and a comprehensive battery of time-varying predictors, (1) smoking bans exhibit differential effects across education groups, (2) smoking bans are most effective at changing behaviors among the most educationally disadvantaged, and (3) this result holds whether educational disadvantage is measured by parental or individual educational attainment. Importantly, these findings provide evidence that an upstream intervention such as smoking bans can shift the educational gradient in meaningful ways.

Discussion

Educational attainment provides access to flexible resources that enable individuals to avoid

[9] For comparison, the coefficient for high school diploma or GED (Table 3, Model 6) is 0.068; when GED is removed (Appendix D), this coefficient is similar at 0.054. In both cases, the difference in the effect of smoking bans from those with less than high school is significant.

health risks (Mirowsky and Ross 2003; Cutler and Lleras-Muney 2010; Authors 2013), and enact healthier lifestyles (Pampel et al. 2010). These resources become particularly important after health hazards are newly identified (Gortmaker and Wise 1997; Link et al. 1998; Frisbie et al. 2004; Lleras-Muney and Lichtenberg 2005; Glied and Lleras-Muney 2008; Chang and Lauderdale 2009; Price and Simon 2009; Polonijo and Carpiano 2013; Yang et al. 2014). Changes in U.S. smoking rates by educational attainment offer a prime example. The availability and dissemination of information about the hazards of smoking prompted strong educational gradients in tobacco use (Baker et al. 2017), a process that was reinforced as smoking came to signal a lower social status (Pampel 2006).

In this article, we examined whether "moving upstream" to implement policies that apply universally have an effect on educational inequalities in health behaviors. We use smoking bans as an example of an upstream policy intervention. Initially prompted by information about the hazards of secondhand smoke (Widome et al. 2010), smoking bans now cover a majority of the U.S. population. Focusing on smoking behavior during young adulthood, a time when most people initiate and quit smoking, we examined the effect of living in a locale when a smoking ban was implemented on educational gradients in young adult smoking. We tested two theoretically informed but competing hypotheses.

In our first set of hypotheses, we posited that smoking bans would have a greater effect on those with parental (H_{1A}) or individual (H_{1B}) educational advantages because they were more susceptible to the denormalization of smoking, and they benefit from other direct and indirect effects of education. We theorized that by intensifying the denormalization of smoking behavior, smoking bans may have amplified educational disparities in smoking, widening the association. We found no evidence in support of these hypotheses.

In our second set of hypotheses, we predicted that smoking bans would have the opposite effect. Because smoking bans apply universally, they represent a type of upstream intervention that circumvents *individual* flexible resources or differences in lifestyles, effectively “bypassing inequality” (Bird and Rieker 2008). We find that living in a locale that implemented a smoking ban prompted greater reductions in smoking among young adults with the lowest parental (H_{2A}) or individual (H_{2B}) educational attainment.

Regarding explanations for the significant effect among individuals with less than a high school degree but not others, we make two points. First, there may be a threshold effect for policies that “level the playing field.” Among this age cohort, high school graduation is highly normative—those who did not complete high school were significantly disadvantaged regarding access to a range of flexible resources. In this case, smoking bans were most effective for the most disadvantaged, those without a high school (or equivalent) degree. The gap between those with and without high school diplomas is greater than distinctions between the other educational categories. These findings cohere with work by Montez and colleagues (2012) identifying that obtaining a high school degree is associated with a steep decline in mortality risk. The acquisition of a high school degree establishes a threshold effect, meaning that earning at least a high school degree has a profound effect on health. From this finding, we infer that a universal smoking ban has a greater impact on smoking (a behavior highly associated with mortality risk) for those who did not complete a high school degree compared to those who did.

Second, our analyses account for behavioral changes relatively early in the life course. Although young adulthood is the period with the most change in smoking status, policy effects on smoking may emerge along a clearer educational gradient as the cohort ages (i.e. the presence of smoking bans may attenuate smoking in other educational groups later in life). Educational advantages for health are likely to accumulate over the life course as these individuals age into midlife and beyond (Willson, Shuey, and Elder 2007); this trend is worth examination in the future. Overall, our results support the argument that the disadvantages associated with not completing high school are already observable relatively early in the life course and are likely passed on intergenerationally.

The consistency of these findings, including measures of both individual and parental educational attainment, provides evidence in support of our hypotheses that smoking bans bypass individual resources and lifestyles, resulting in narrower educational inequalities in smoking. They also assuage concerns that marshalling denormalization will accentuate educational inequalities in smoking by disproportionately motivating changes among educationally advantaged individuals. Although we cannot say definitively whether smoking bans change stigma for continuing smokers, who remain disproportionately within the lower strata, we can conclude that smoking bans do not entrench smoking stigma in a way that prevents effective upstream policy intervention. From a population health perspective, declining tobacco use in adolescence and young adulthood among those with the lowest levels of educational attainment should translate into increases in life expectancy, and a non-trivial reduction in mortality gradients (Rostron and Wilmoth 2011; Ho and Fenelon 2015).

Aside from testing the effect of smoking bans, the primary theoretical contribution of this research is testing the notion that upstream policy interventions that apply universally may ameliorate educational inequalities in health. These findings underscore the need to examine and clarify the circumstances under which policies, as upstream interventions, ameliorate inequalities in health behaviors or outcomes. First, our findings suggest that it is important to consider when health habits form during the life course, and identify stages when upstream policies have greater effects on health behavior changes. For example, Dinno and Glantz (2009) found that, among adults aged 15-80, smoking bans prompted behavioral changes similarly across educational attainment. Given that smoking initiation and cessation occur most frequently during adolescence and young adulthood (Messer et al. 2008; Chen and Jacques-Tiura 2014), examining adults across all life stages may hamper our capacity to understand the effect among those most inclined to change and thus benefit from such policies. Importantly, these prior studies use cross-sectional data that cannot determine within-person effects that demonstrate the effects of policy implementation on *changes within* individuals.

Second, our approach extends prior work by incorporating measures of both parental and individual educational attainment. It is reasonable to consider how linked lives dictate the flexible resources, or health lifestyles, that are available to or influence individual behaviors (Authors 2009; Umberson et al. 2010). We noted that there is not a perfect match between the two measures (Table 2) and smoking rates exhibit different patterns (Figure 2). Despite these differences, we found similar results when considering the effect of smoking bans within these categories. Thus, at least in terms of this particular upstream intervention, both play out similarly within the same level of educational attainment, even though the same individuals do not always occupy the same position on those two measures of socioeconomic status.

Limitations

Our study is not without limitations. First, regarding the data, we reiterate that our findings only apply to young people. We note, however, that using this cohort has many advantages, in particular a rapidly changing policy environment at precisely the point in the life course with the most variability in substance use, which provides the within-person variability necessary to examine the effects of an upstream policy on individual-level behavior. Second, we used a subset of young people whose city of residence could be identified. As such, our results should be generalized to young people who live in such principal cities. Again, this subset provides for the advantageous ability to account for city-level policy effects, an important level typically ignored in past studies.

Regarding our coding and analytic strategy, we respond to three additional limitations. For our second set of models, we coded individual educational attainment by the respondent's attainment at the final observation point. Such an approach has been justified in past studies of tobacco use, as the benefits of education that are associated with differences in smoking are largely in place by young adulthood (Maralani 2014; Pampel et al. 2014). Moreover, our main findings for those with less than a high school degree would not change; changes in educational attainment would only apply to those who participated in higher education. Additionally, we examined smoking at least intermittently in the past month as our outcome. Although we found similar results using a less frequent measure of smoking in the form of any smoking in the past 30 days (not shown), if an individual is an especially heavy smoker by young adulthood, as measured by consuming at least a pack per day, that smoking status does not exhibit sufficient within-person change. Yet, this lack of variation exists for all educational categories, and when respondents smoked at least intermittently, they were still on average fairly regular smokers. Finally, our individual-level FE modeling procedure did not allow for city-level clustering, as individuals are not strictly nested within cities. This concern is attenuated by our modeling procedure whereby stable city-level characteristics would still be netted out of the model, and by similar results for alternative modeling such as random effects models.

Directions for Future Research

Regarding upstream health interventions that, to a certain extent, neutralize the effect of socioeconomic inequalities on access to flexible resources, we elucidate additional distinctions that merit further investigation. As an example of an upstream policy intervention, smoking bans reflect efforts by policymakers and public health advocates in positions of power to *restrict* individual behavior and motivate change by denormalizing smoking. Although we did not find evidence that denormalization via smoking bans amplified existing educational inequalities in smoking, denormalization processes may operate differently in other settings, for different health behaviors, or for subgroup populations. For example, the cohort in our study may have been susceptible to denormalization because smoking was already increasingly stigmatized by the time most bans were implemented (Widome et al. 2010). Future research and policy efforts should be mindful of the effect of stigmatizing health behaviors, particularly among those with the fewest resources to enact individual change.

By offering a theoretically motivated empirical test of the effect of one type of upstream intervention on educational inequalities in smoking behavior, we provide a vantage point for future research on the effects of these policies in other contexts and outcomes. Our data and methodological approach offer key advantages over prior analyses of the effects of smoking bans on behavioral changes in smoking by educational attainment. Our findings advance understandings of the contexts that may foster the efficacy of policies, as upstream interventions, to attenuate educational inequalities in population health.

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Table 1: Descriptive Statistics

	FULL SAMPLE Average / % (SD)	SMOKING Average / % (SD)	NON-SMOKING Average / % (SD)
Smoke 8 or more cigarettes in past month (%)	28.90	100.00	0.00
Time-Varying Policy Measures			
Smoking ban (%)	36.29	33.84	37.31
Single cigarette sale restrictions (%)	33.05	30.57	34.06
Any tobacco ad restrictions (%)	64.64	58.70	67.05
Cigarette excise taxes	1.26 (1.05)	1.22 (1.01)	1.28 (1.07)
Time-Varying City Measures			
Population (vs. 100,000 or less)			
100,000-250,000 (%)	17.67	18.37	17.31
250,000-500,000 (%)	12.62	13.80	12.24
500,000-1,000,000 (%)	18.62	17.35	19.15
1,000,000 plus (%)	27.33	21.07	29.86
Log of population density	8.13 (0.98)	8.00 (0.953)	8.19 (0.98)
Owner occupied housing	50.26 (9.86)	51.58 (9.77)	49.73 (9.83)
Minor (%)	23.57 (3.53)	23.57 (3.41)	23.57 (3.58)
Female headed households (%)	12.09 (3.80)	12.12 (3.71)	12.05 (3.83)
Non-Hispanic whites (%)	49.03 (21.02)	52.94 (21.58)	47.50 (20.63)
Time-Varying Respondent Measures			
Age	24.82 (2.73)	24.75 (2.72)	24.85 (2.73)
Married (%)	20.85	17.22	22.56
Living with a parent (%)	25.89	24.54	26.26
Employment Status (vs. none)			
Part-time (%)	23.26	22.34	23.69
Full-time (%)	51.05	48.57	52.50
Job Schedule (vs. none)			
Day (%)	53.14	50.31	54.51
Night (%)	5.28	6.72	4.65
Irregular (%)	24.39	23.27	25.09
Occupation (vs. not employed)			
Management and Professional (%)	23.12	13.64	27.30
Service (%)	22.22	26.83	20.24
Sales and Office (%)	25.31	23.14	26.39
Construction (%)	7.03	10.89	5.44
Production and Transportation (%)	10.46	12.62	9.45
Recent county move (%)	14.12	14.65	13.97
Parent (%)	40.72	46.77	37.80

Note: Descriptive statistics are pooled across years using analytic sample for individual education (respondents = 4,806; observations = 21,506)

Table 2: Relationship between Parental and Individual Educational Attainment

	Individual Educational Attainment				
Parental Educational Attainment	Less than high school	High school degree or GED	Some college, no degree	Associate's degree	Bachelor's degree or higher
Less than high school	170 (23.22%)	274 (37.43%)	193 (26.37%)	32 (4.37%)	63 (8.61%)
High school degree or GED	173 (12.28%)	430 (30.52%)	510 (36.20%)	97 (6.88%)	199 (14.12%)
Some college, no degree, or Associate's degree	74 (6.20%)	239 (20.03%)	465 (38.98%)	94 (7.88%)	321 (26.91%)
Bachelor's degree or higher	17 (1.23%)	131 (9.45%)	352 (25.40%)	90 (6.49%)	796 (57.43%)

Note: Shaded cells depict what percent of respondents completed the same level of education as their parents.

Table 3: Fixed Effects Linear Probability Models of Past Month Smoking, Overall & Interactions with Parental and Individual Educational Attainment

	A. All Education		B. Parents		C. Individual	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	β (SE)	β (SE)	β (SE)	β (SE)	β (SE)	β (SE)
Smoking ban	-0.036 ***	-0.020 **	-0.080 ***	-0.064 ***	-0.102 ***	-0.086 ***
	(0.006)	(0.007)	(0.014)	(0.015)	(0.019)	(0.020)
*Smoking ban * Education*						
Parental (vs. less than high school)						
High School Degree	--	--	0.061 ***	0.063 ***	--	--
			(0.018)	(0.018)		
Some College or Associate's Degree	--	--	0.043 *	0.039 *	--	--
			(0.019)	(0.019)		
Bachelor's degree or higher	--	--	0.046 **	0.049 **	--	--
			(0.018)	(0.018)		
Individual (vs. less than high school)						
High school Degree or GED	--	--	--	--	0.070 **	0.068 **
					(0.023)	(0.023)
Some College	--	--	--	--	0.077 ***	0.076 ***
					(0.022)	(0.022)
Associate's Degree	--	--	--	--	0.017	0.019
					(0.030)	(0.030)
Bachelor's Degree	--	--	--	--	0.084 ***	0.085 ***
					(0.022)	(0.022)
Time-Varying Policy Measures						
Single cigarette sale restrictions	--	0.002	--	0.001	--	0.001
		(0.007)		(0.007)		(0.007)
Any tobacco ad restrictions	--	-0.022	--	-0.028	--	-0.023
		(0.017)		(0.017)		(0.017)
Cigarette excise taxes	--	-0.007	--	-0.008 *	--	-0.008 *
		(0.004)		(0.004)		(0.004)
Time-Varying City Measures						
Population (vs. 100,000 or less)						
100,000-250,000	--	0.014	--	0.015	--	0.013
		(0.016)		(0.016)		(0.016)
250,000-500,000	--	-0.011	--	-0.011	--	-0.013
		(0.020)		(0.021)		(0.020)
500,000-1,000,000	--	-0.006	--	-0.003	--	-0.007
		(0.020)		(0.020)		(0.020)
1,000,000 plus	--	0.012	--	0.016	--	0.012
		(0.026)		(0.027)		(0.026)
Log of population density	--	0.004	--	0.005	--	0.001
		(0.012)		(0.012)		(0.012)
Owner occupied housing	--	0.000	--	0.000	--	0.000
		(0.001)		(0.001)		(0.001)
% Minor	--	0.001	--	0.002	--	0.001
		(0.003)		(0.003)		(0.003)
% Female headed households	--	-0.006 *	--	-0.006 *	--	-0.006 *
		(0.003)		(0.003)		(0.003)
% Non-Hispanic whites	--	-0.001	--	-0.001	--	-0.001
		(0.001)		(0.001)		(0.001)

Table 3: Fixed Effects Linear Probability Models of Past Month Smoking, Overall & Interactions with Parental and Individual Educational Attainment (continued)

	A. All Education		B. Parents		C. Individual	
	Model 1 β (SE)	Model 2 β (SE)	Model 3 β (SE)	Model 4 β (SE)	Model 5 β (SE)	Model 6 β (SE)
Time-Varying Respondent Measures						
Age	--	0.017 (0.012)	--	0.020 (0.012)	--	0.018 (0.012)
Age^2	--	-0.000 (0.000)	--	-0.001 * (0.000)	--	0.000 * (0.000)
Married	--	-0.007 (0.009)	--	-0.008 (0.009)	--	-0.009 (0.009)
Living with a parent	--	0.019 ** (0.007)	--	0.019 ** (0.007)	--	0.02 ** (0.007)
Employment Status (vs. none)						
Part-time	--	0.014 (0.008)	--	0.014 (0.008)	--	0.014 (0.008)
Full-time	--	0.012 (0.008)	--	0.014 (0.008)	--	0.012 (0.008)
Job Schedule (vs. none)						
Day	--	-0.011 (0.011)	--	-0.013 (0.011)	--	-0.011 (0.011)
Night	--	0.020 (0.014)	--	0.022 (0.014)	--	0.020 (0.014)
Irregular	--	-0.014 (0.011)	--	-0.015 (0.012)	--	-0.013 (0.011)
Occupation (vs. not employed)						
Management and Professional	--	0.001 (0.013)	--	-0.000 (0.013)	--	0.000 (0.013)
Service	--	0.016 (0.012)	--	0.015 (0.012)	--	0.015 (0.012)
Sales and Office	--	0.006 (0.012)	--	0.007 (0.012)	--	0.006 (0.012)
Construction	--	0.021 (0.015)	--	0.017 (0.016)	--	0.020 (0.015)
Production and Transportation	--	0.012 (0.013)	--	0.008 (0.013)	--	0.012 (0.013)
Recent county move	--	-0.000 (0.006)	--	-0.001 (0.006)	--	0.000 (0.006)
Parent	--	0.009 (0.010)	--	0.014 (0.010)	--	0.008 (0.010)
Constant	0.303 *** (0.003)	0.207 (0.210)	0.306 *** (0.003)	0.167 (0.212)	0.303 *** (0.003)	0.220 (0.210)
Respondents	21,506	21,506	20,626	20,626	21,506	21,506
Observations	4806	4806	4624	4624	4806	4806

Note: *p<.05; ** p<.01; ***p<.001 (two tailed). Models 1 and 2 show the effect of smoking bans without considering for education. Models 3 and 4 show the interaction between smoking bans and parental education. Models 5 and 6 show the same interaction with individual education. See text for more details.

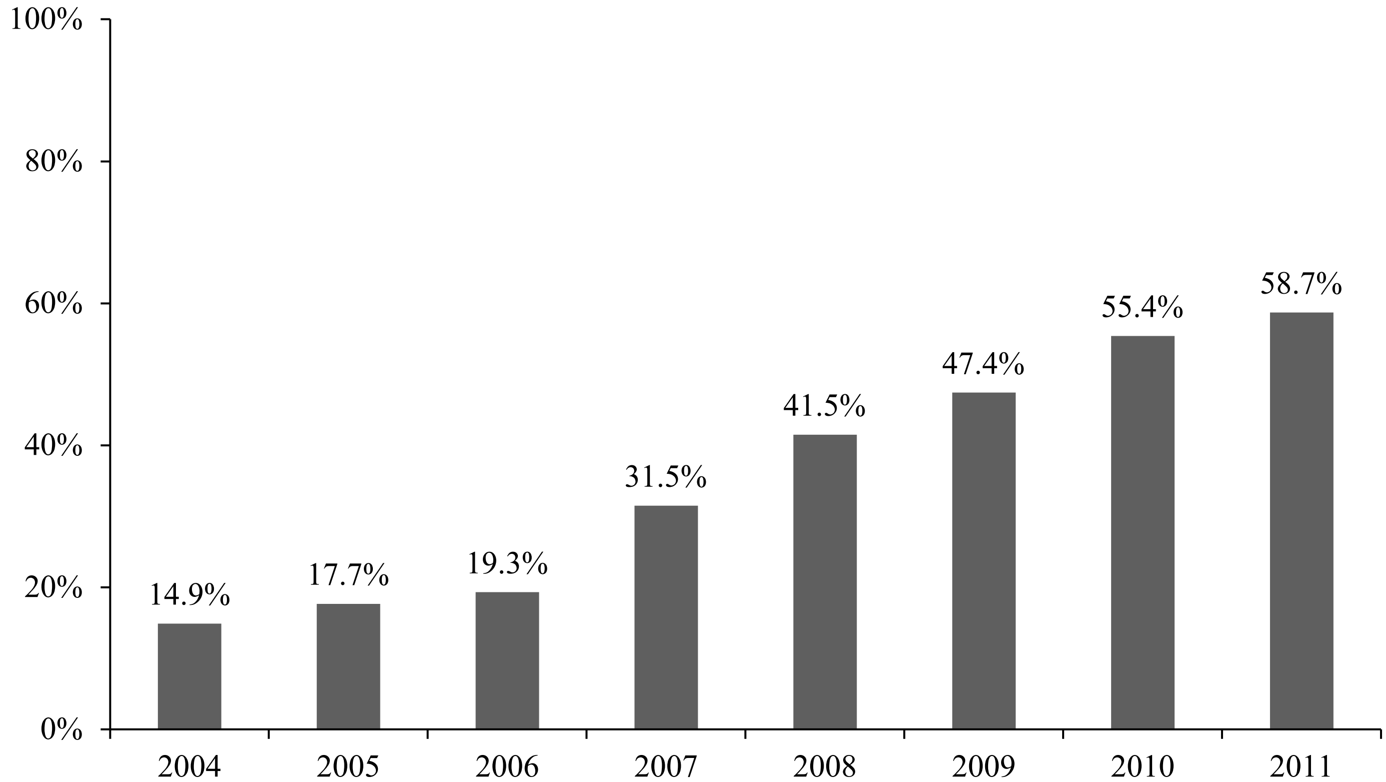

Fig. 1 Percentage of Respondents Living in a City with a Comprehensive Smoking Ban by Year

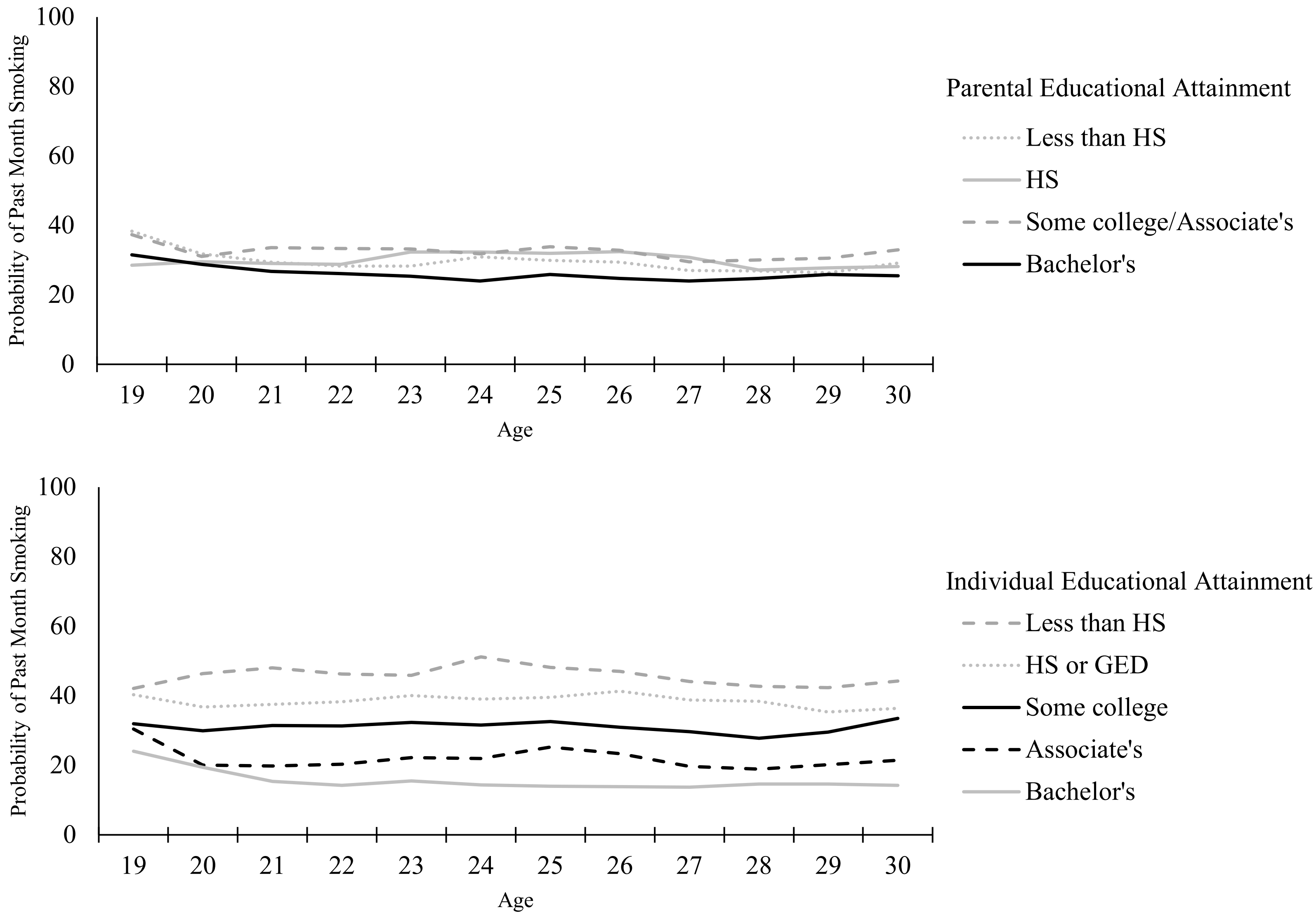

Fig. 2 Probability of Past Month Smoking by Parental and Individual Educational Attainment and Age

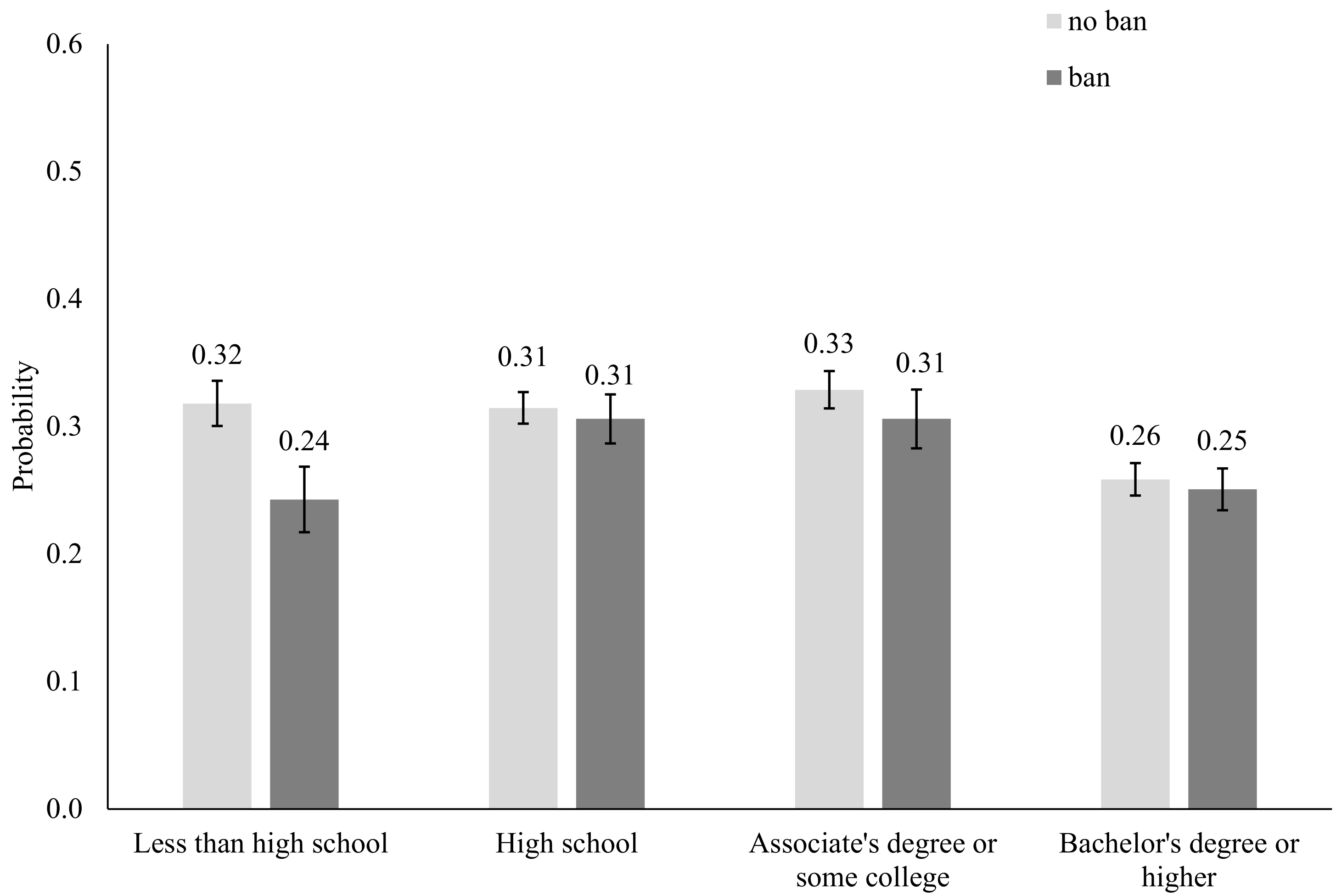

Fig. 3 Predicted Probability of Past Month Smoking by Parental Educational Attainment and Presence of Tobacco Clean Air Act

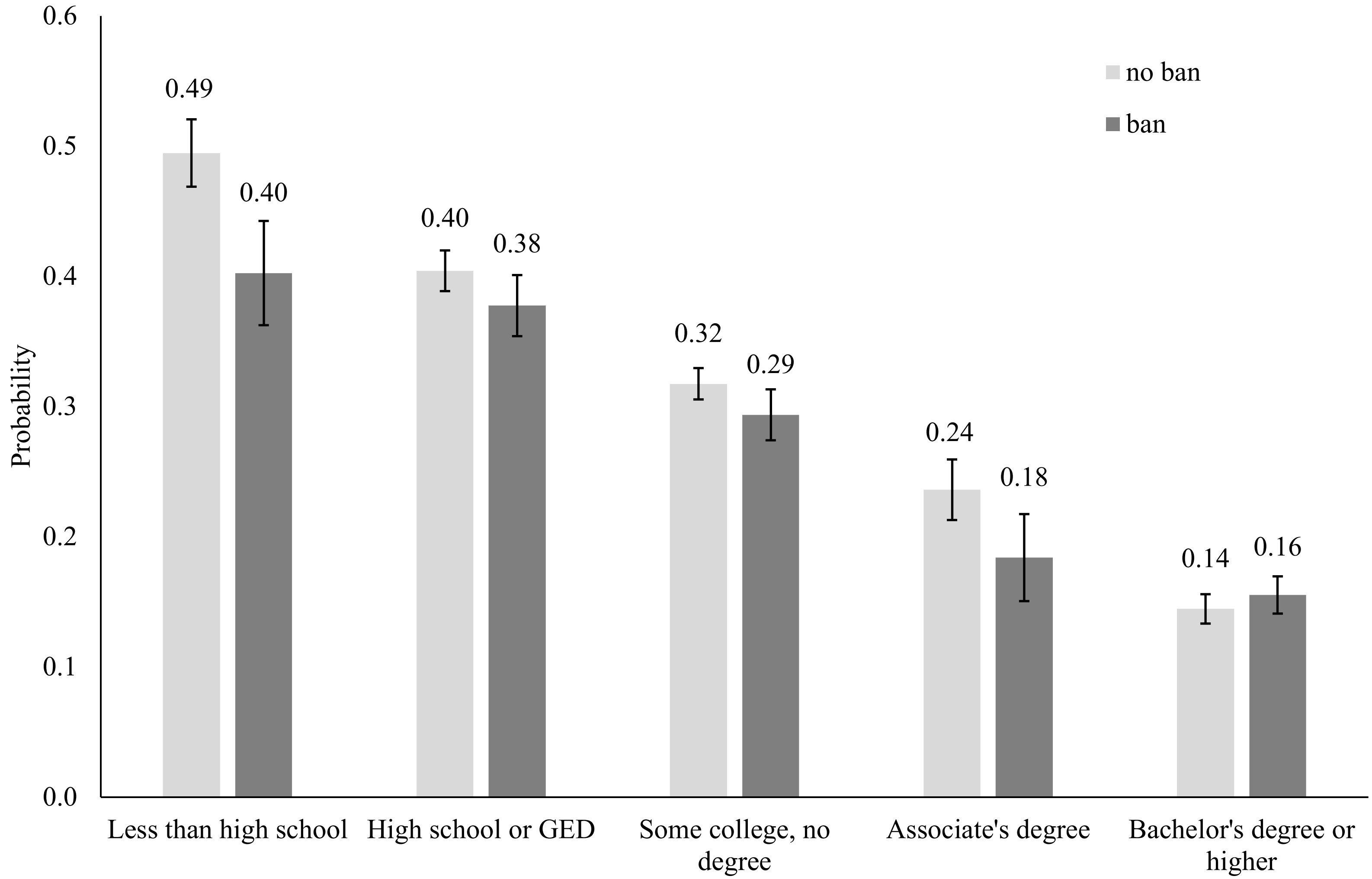

Fig. 4 Predicted Probability of Past Month Smoking by Individual Educational Attainment and Presence of Tobacco Clean Air Act

Appendix A. Patterns of Smoking at least 8 Cigarettes in the Past Month by Parental and Individual Educational Attainment and Age

Percent smoking at least 8 cigarettes in past month

	19	20	21	22	23	24	25	26	27	28	29	30	Average
All respondents	33.0	29.8	29.2	28.9	29.9	29.4	29.9	29.5	27.8	27.2	27.2	28.7	29.0
Parents Educational Attainment													
Less than high school	38.3	31.8	29.4	28.3	28.3	30.9	30.0	29.5	27.0	26.9	26.4	29.2	29.1
High school	28.6	29.5	29.0	28.8	32.4	32.4	31.9	32.4	30.8	27.2	27.8	28.2	30.6
Some college or Associate's degree	37.3	31.1	33.6	33.4	33.2	31.9	33.9	32.9	29.5	30.0	30.5	32.9	32.2
Bachelor's degree	31.5	28.8	26.7	26.2	25.4	24.0	25.8	24.7	24.0	24.7	25.9	25.5	25.3
Individual Educational Attainment													
Less than high school	42.1	46.3	48.0	46.2	45.9	51.2	48.1	47.0	44.1	42.7	42.3	44.3	46.6
High school or GED	40.3	36.8	37.5	38.2	40.1	39.0	39.5	41.3	38.8	38.4	35.3	36.4	38.8
Some college	31.9	29.9	31.4	31.3	32.3	31.5	32.6	30.9	29.7	27.8	29.5	33.5	31.0
Associate's degree	30.4	20.0	19.8	20.3	22.2	21.9	25.3	23.3	19.6	18.9	20.2	21.4	21.7
Bachelor's degree	24.1	19.4	15.4	14.3	15.5	14.4	14.0	13.9	13.7	14.6	14.6	14.2	14.7

Percent of smokers within each education category by age

	19	20	21	22	23	24	25	26	27	28	29	30	Average percent of smokers	Percent of full sample
Parents Educational Attainment														
Less than high school	20.2	18.0	16.6	15.2	14.8	17.0	16.3	16.7	16.3	16.8	17.4	17.0	16.5	16.8
High school	29.8	31.8	30.6	30.3	33.0	32.1	31.7	32.2	33.8	31.1	31.5	29.9	31.8	30.6
Some college or Associate's degree	24.6	22.5	27.6	28.4	28.2	26.6	27.3	27.1	25.8	26.1	25.8	28.4	26.8	24.2
Bachelor's degree	25.4	27.7	25.2	26.1	24.0	24.4	24.7	24.0	24.2	26.1	25.2	24.7	24.9	28.5
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Individual Educational Attainment														
Less than high school	13.56	15.94	16.44	16.52	13.75	15.99	15.36	15.56	14.56	14	12.87	13.24	15.15	9.81
High school or GED	26.27	28.26	28.01	29.64	30.87	30.5	30.59	33.21	33.78	34.4	32.75	32.84	31.36	23.73
Some college	38.14	34.78	36.34	35.26	35.67	34.19	35.07	32.23	32.28	31	33.92	34.8	34.05	31.72
Associate's degree	5.93	4.71	4.86	4.94	4.93	5.04	5.56	5.51	4.95	4.8	5.26	4.41	5.1	6.73
Bachelor's degree	16.1	16.3	14.35	13.63	14.79	14.27	13.42	13.48	14.41	15.8	15.2	14.71	14.34	28.02
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Note: The top panel displays the percentage of our entire analytic sample that smoked 8 or more cigarettes in the past month by each age and educational attainment. The bottom panel uses only smokers as the denominator, thus dispaying the share of smokers within each educational attainment group. For comparison, the final column shows the percentage of the full sample in each educational attainment category independent of smoking.

Appendix B: Fixed Effects Linear Probability Models for Past Month Smoking by Parental Education

	Sample			
	Less than high school	High school degree	Some college	Bachelor's degree or higher
	β (SE)	β (SE)	β (SE)	β (SE)
Smoking ban	-0.075 ***	-0.009	-0.023	-0.008
	(0.018)	(0.013)	(0.016)	(0.012)
Time-Varying Policy Measures				
Single cigarette sale restrictions	-0.027	-0.001	-0.006	0.016
	(0.019)	(0.014)	(0.016)	(0.012)
Any tobacco ad restrictions	-0.175 *	-0.105 **	0.059	-0.022
	(0.072)	(0.036)	(0.040)	(0.023)
Cig. excise taxes	-0.024 *	-0.017 *	-0.014	0.010
	(0.011)	(0.007)	(0.009)	(0.007)
Time-Varying City Measures				
Population (vs. 100,000 or less)				
100,000-250,000	0.140 *	-0.022	-0.077 *	0.066 **
	(0.058)	(0.030)	(0.037)	(0.026)
250,000-500,000	0.083	-0.068	-0.152 **	0.080 *
	(0.069)	(0.039)	(0.048)	(0.032)
500,000-1,000,000	0.067	0.031	-0.137 **	0.039
	(0.072)	(0.040)	(0.046)	(0.031)
1,000,000 plus	0.057	-0.024	-0.062	0.057
	(0.080)	(0.059)	(0.061)	(0.040)
Log of population density	0.023	-0.010	0.012	0.010
	(0.046)	(0.024)	(0.031)	(0.017)
Owner occupied housing	0.003	-0.003	0.004	-0.000
	(0.004)	(0.002)	(0.003)	(0.001)
% Minor	-0.016	0.012	-0.009	0.004
	(0.009)	(0.006)	(0.007)	(0.004)
% Female headed households	-0.014	-0.014*	0.005	-0.007
	(0.008)	(0.006)	(0.006)	(0.004)
% Non-Hispanic whites	-0.004	-0.002	-0.002	0.001
	(0.002)	(0.001)	(0.001)	(0.001)

Appendix B: Fixed Effects Linear Probability Models for Past Month Smoking by Parental Education (continued)

	Sample			
	Less than high school	High school degree	Some college	Bachelor's degree or higher
	β (SE)	β (SE)	β (SE)	β (SE)
Age	-0.007	0.042	0.005	0.007
	(0.031)	(0.022)	(0.028)	(0.023)
Age^2	-0.000	-0.001*	-0.000	-0.000
	(0.001)	(0.000)	(0.001)	(0.000)
Married	0.026	-0.013	0.030	-0.042**
	(0.023)	(0.016)	(0.019)	(0.015)
Living with a parent	0.006	0.033**	0.025	0.009
	(0.017)	(0.012)	(0.015)	(0.015)
Employment Status (vs. none)	0.016	-0.004	0.018	0.026
Part-time	(0.020)	(0.015)	(0.018)	(0.015)
Full-time	0.001	0.007	0.013	0.030*
	(0.019)	(0.014)	(0.017)	(0.014)
Job Schedule (vs. none)				
Day	0.007	0.010	-0.007	-0.057**
	(0.025)	(0.019)	(0.024)	(0.021)
Night	0.050	0.052*	0.008	-0.015
	(0.033)	(0.025)	(0.030)	(0.028)
Irregular	0.035	-0.001	-0.020	-0.056**
	(0.028)	(0.020)	(0.025)	(0.021)
Occupation (vs. not employed)				
Management and Professional	0.019	-0.013	-0.001	0.022
	(0.033)	(0.023)	(0.027)	(0.023)
Service	-0.032	0.012	0.028	0.040
	(0.027)	(0.020)	(0.026)	(0.024)
Sales and Office	0.020	-0.016	-0.003	0.038
	(0.027)	(0.020)	(0.026)	(0.023)
Construction	0.062	-0.032	0.056	0.004
	(0.036)	(0.027)	(0.034)	(0.030)
Production and Transportation	0.025	-0.008	0.002	0.021
	(0.030)	(0.023)	(0.030)	(0.027)
Recent county move	0.001	-0.001	-0.001	-0.002
	(0.020)	(0.012)	(0.014)	(0.010)
Parent	0.005	0.037*	-0.018	0.016
	(0.025)	(0.017)	(0.021)	(0.018)
Constant	1.006	0.154	0.241	0.158
	(0.646)	(0.415)	(0.512)	(0.343)

Note: *p <.05; ** p <.01; ***p <.001 (two tailed)

Appendix C: Fixed Effects Linear Probability Models for Past Month Smoking by Individual Education

	Sample				
	Less than high school	High school degree or GED	Some college	Associate's Degree	Bachelor's degree or higher
	β (SE)	β (SE)	β (SE)	β (SE)	β (SE)
Smoking ban	-0.092 ***	-0.027	-0.024	-0.052 *	0.011
	(0.027)	(0.016)	(0.013)	(0.024)	(0.010)
Time-Varying Policy Measures					
Single cigarette sale restrictions	-0.066 *	-0.010	-0.004	0.024	0.019
	(0.030)	(0.017)	(0.014)	(0.025)	(0.011)
Any tobacco ad restrictions	-0.047	-0.144 **	-0.056	0.082	0.005
	(0.138)	(0.056)	(0.036)	(0.071)	(0.019)
Cig. excise taxes	-0.028	-0.015	-0.03 ***	0.012	0.008
	(0.017)	(0.010)	(0.008)	(0.012)	(0.005)
Time-Varying City Measures					
Population (vs. 100,000 or less)					
100,000-250,000	0.013	0.041	0.020	0.022	-0.008
	(0.098)	(0.046)	(0.031)	(0.051)	(0.021)
250,000-500,000	0.256	0.025	-0.041	-0.039	-0.061 *
	(0.099)	(0.058)	(0.041)	(0.076)	(0.026)
500,000-1,000,000	0.264 **	0.067	-0.017	0.005	-0.072 **
	(0.099)	(0.055)	(0.041)	(0.099)	(0.025)
1,000,000 plus	0.214	0.058	0.141 **	0.090	-0.119 ***
	(0.154)	(0.079)	(0.051)	(0.122)	(0.033)
Log of population density	-0.101	0.028	-0.025	-0.034	0.022
	(0.087)	(0.036)	(0.025)	(0.041)	(0.014)
Owner occupied housing	-0.001	-0.000	0.004 *	0.000	-0.000
	(0.007)	(0.003)	(0.002)	(0.004)	(0.001)
% Minor	0.007	0.004	-0.012 *	-0.002	0.006 *
	(0.016)	(0.008)	(0.006)	(0.011)	(0.003)
% Female headed households	-0.019	-0.016 *	-0.003	-0.013	-0.006
	(0.016)	(0.008)	(0.005)	(0.011)	(0.003)
% Non-Hispanic whites	-0.002	-0.002	-0.001	0.000	-0.001 *
	(0.004)	(0.002)	(0.001)	(0.002)	(0.001)

Appendix C: Fixed Effects Linear Probability Models for Past Month Smoking by Individual Education (Continued)

	Sample				
	Less than high school	High school degree or GED	Some college	Associate's Degree	Bachelor's degree or higher
	β (SE)	β (SE)	β (SE)	β (SE)	β (SE)
Age	-0.018	0.039	0.009	-0.010	0.008
	(0.047)	(0.028)	(0.022)	(0.040)	(0.020)
Age^2	0.000	-0.001	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)
Married	0.068	0.015	-0.012	-0.031	-0.022
	(0.040)	(0.020)	(0.016)	(0.025)	(0.013)
Living with a parent	0.023	0.033 *	0.028 *	-0.05 *	0.021
	(0.024)	(0.015)	(0.013)	(0.023)	(0.013)
Employment Status (vs. none)					
Part-time	-0.003	0.006	0.057 ***	-0.015	-0.021
	(0.028)	(0.018)	(0.014)	(0.028)	(0.014)
Full-time	-0.003	0.006	0.043 **	-0.003	-0.010
	(0.027)	(0.017)	(0.014)	(0.028)	(0.013)
Job Schedule (vs. none)					
Day	0.017	0.012	-0.04 *	0.052	-0.023
	(0.033)	(0.024)	(0.019)	(0.042)	(0.020)
Night	0.080	0.052	-0.021	0.037	0.009
	(0.049)	(0.029)	(0.024)	(0.051)	(0.027)
Irregular	0.045	-0.002	-0.062 **	0.058	-0.008
	(0.037)	(0.025)	(0.020)	(0.043)	(0.020)
Occupation (vs. not employed)					
Management and Professional	0.016	0.019	0.020	0.002	0.003
	(0.059)	(0.035)	(0.024)	(0.044)	(0.021)
Service	-0.002	-0.028	0.036	0.034	0.021
	(0.034)	(0.025)	(0.021)	(0.044)	(0.023)
Sales and Office	0.003	-0.016	0.020	0.027	-0.002
	(0.038)	(0.025)	(0.021)	(0.042)	(0.022)
Construction	0.12 **	-0.026	-0.001	0.018	0.037
	(0.045)	(0.030)	(0.028)	(0.064)	(0.033)
Production and Transportation	-0.004	-0.030	0.048 *	0.015	0.004
	(0.037)	(0.027)	(0.024)	(0.051)	(0.029)
Recent county move	-0.037	0.012	-0.006	0.042	-0.001
	(0.030)	(0.017)	(0.012)	(0.023)	(0.008)
Parent	0.018	-0.003	0.028	0.004	-0.019
	(0.042)	(0.021)	(0.018)	(0.029)	(0.016)
Constant	1.689	0.075	0.602	0.898	0.089
	(1.138)	(0.565)	(0.412)	(0.733)	(0.304)

Note: *p <.05; ** p <.01; ***p <.001 (two tailed)

Appendix D: Fixed Effects Linear Probability Models of Past Month Smoking, with Interation with Individual Educational Attainment with GPA as Separate Category

	β (SE)	
Smoking ban	-0.086	***
	(0.020)	
*Smoking ban * Education*		
Individual (vs. less than high school)		
High School Equivalency Diploma (GED)	0.088	**
	(0.028)	
High school Degree	0.054	*
	(0.025)	
Some College	0.076	***
	(0.022)	
Associate's Degree	0.019	
	(0.030)	
Bachelor's Degree	0.085	***
	(0.022)	

Note: Test of equivalence of GED and HS coefficient: $F(1,16666) = 1.89$, $p>.05$. Model includes all controls.